ASL

AIRS Retrievals of Dust-Contaminated Cloud-Cleared Radiances

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Desert Dust

Science and Climate :

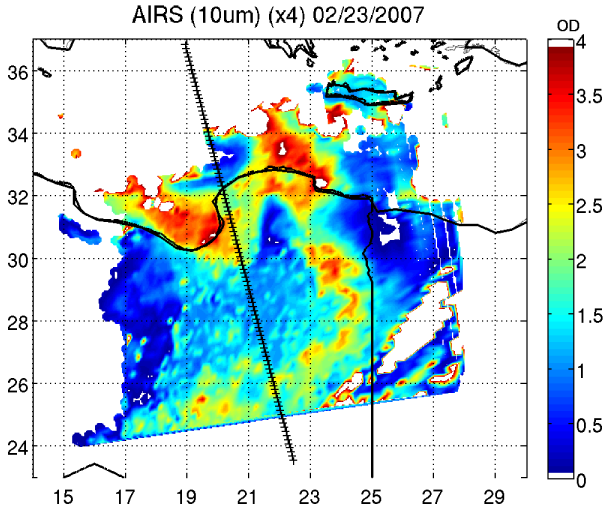
- (Mineral) desert dust storms can spread over vast geographical areas during different seasons
- Magnitude of climate forcing by clouds/aerosols is uncertain, and is as large as that due to greenhouse gases (IPCC 2007)
- AIRS can directly measure longwave forcing
- Dust in the atmosphere can dry/heat atmospheric layers and change stability of the atmosphere

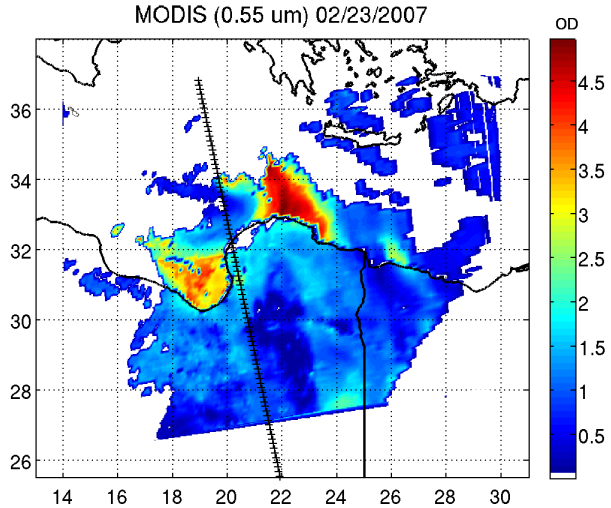
AIRS L2 products :

- Can significantly reduce yield and accuracy of L2 products
- We hope to show that our scattering RTA with dust retrievals can improve the L2 products, and their accuracy
- Dust, if ignored, can preclude AIRS helping with Atlantic hurricane forecasts

Comparisons with A-Train Instruments

- We have performed an extensive comparison between AIRS and other A-Train instruments that measure mineral dust
- AIRS competitive with MODIS, POLDER, OMI, CALIPSO
- AIRS works day/night, over land/ocean (no sunglint problems)
- Can retrieve dust layer heights, and estimate OLR dust forcing
- MODIS can display unphysical discontinuities going from ocean to bright land surfaces (deserts!) compared to AIRS
- CALIPSO has excellent vertical resolution but over very limited area. aux



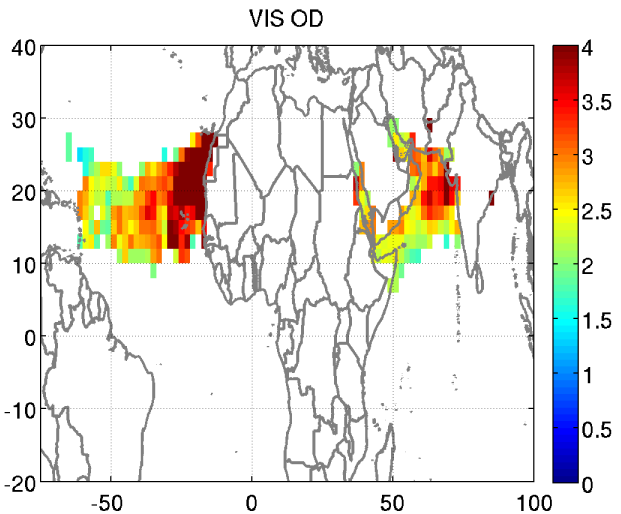


Dust event

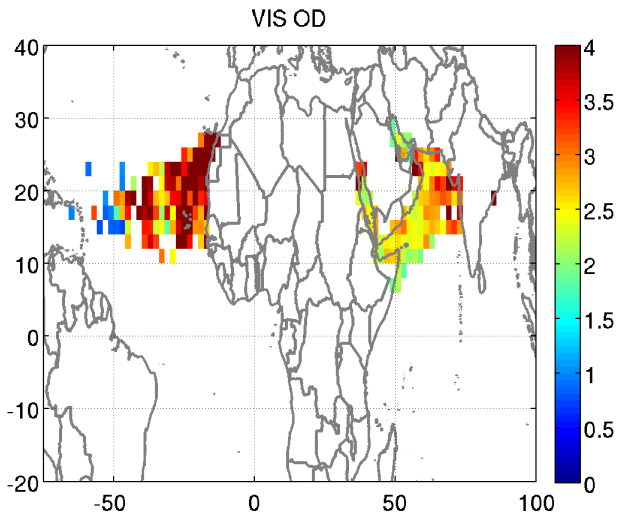
We chose a new dust event for this study

- Major dust episode week of June 21-25, 2008
- Retrieved optical depth (OD) using Rodger's type minimization. ECMWF for initial guess.
- Effect of dust: VIS OD value of 4 (thick dust) corresponds to AIRS (obs-calc) about (-1.3,-3.3) K at (820 cm^{-1},960 cm^{-1})

(L) L1B rads



(R) L2CC rads



Method

- 2 um effective radius, with scattering parameters from Volz
- dust layer heights from GOCART climatology (1km thick).
- Use LW channels to fit {dust amount, stemp, T(z), Water(z)}
- UMBC Optimal Estimation method starts with ECMWF
- remember factor of $\simeq$ 9 reduction going from L1B to L2CC

What	Number of FOVS	Time Span
L1B (dusty)	36327	6/21-6/26/2008
L2CC (dusty)	4595	6/21-6/26/2008
L2CC (our random clear)	1512	6/21/2008

Yield

UMBC sea emissivity = Masuda

Success = bias for following channels $\leq \delta BT_{max}$

- dust affected window channels : 822, 961, 1231 cm^{-1}
- Water channel 1436.5 cm^{-1}, Temp channel 773.6 cm^{-1}

Fractional yield, having started with ECMWF profiles

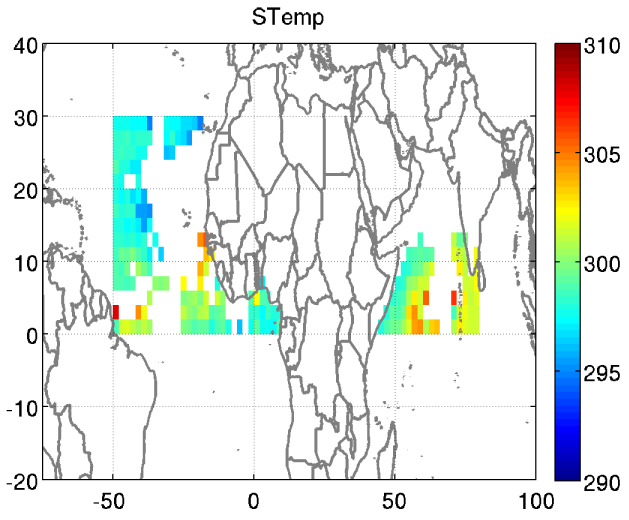
	Num FOVS	δBT_{max}	yield
L1B	36327	1.0	0.73
(visOD $\leq$ 4)		2.0	0.75
(dust flag)			
L2CC	4595	1.0	0.60
(visOD $\leq$ 4)		2.0	0.67
(dust flag)			
L2CC	1512	1.0	0.97
randomly clear		2.0	0.99
(quality flag = 0)			
(visOD $\leq$ 0.01)			

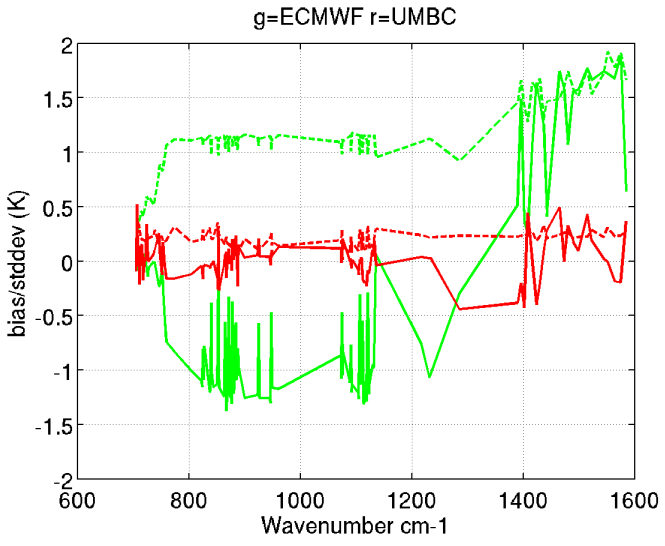
L2CCR w/ no dust

Check out our retreival w/o dust contamination

Choose L2CC qual=0 (best) radiances with no dust signature
Look at biases (solid), stddev(dash)

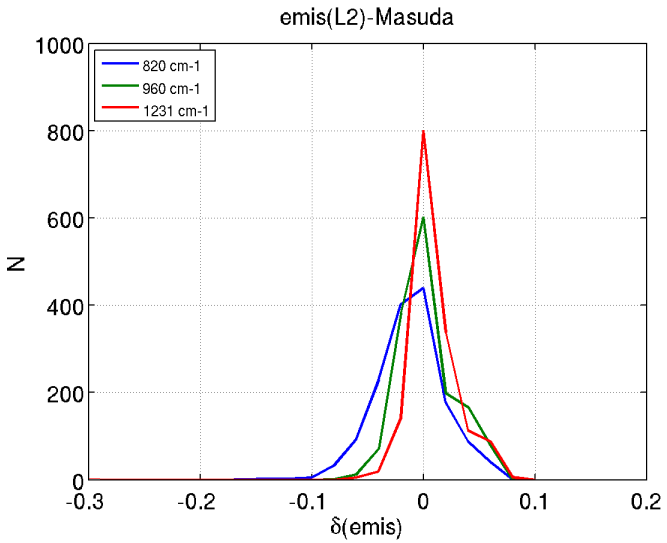
(L) area coverage (R) biases



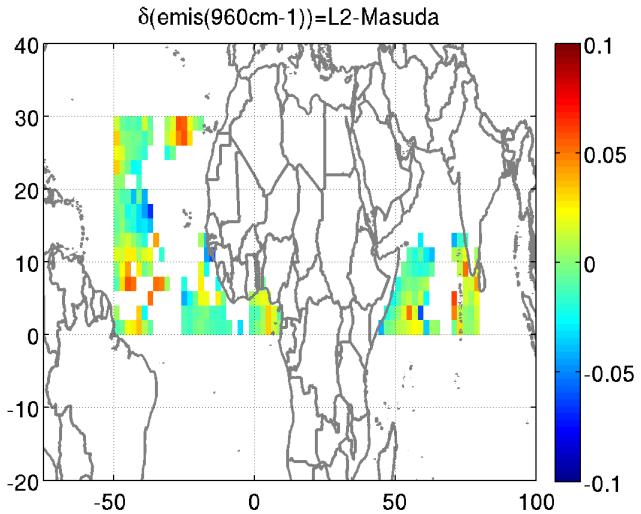


L2CCR w/ no dust: Emissivity

(L) histogram

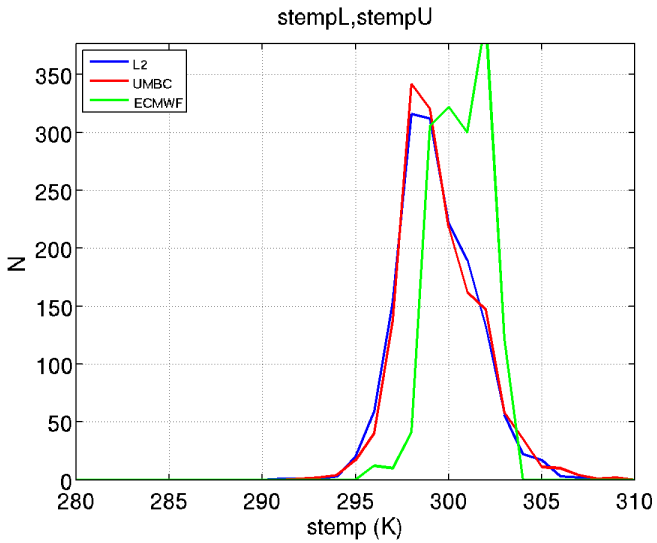


(R) map

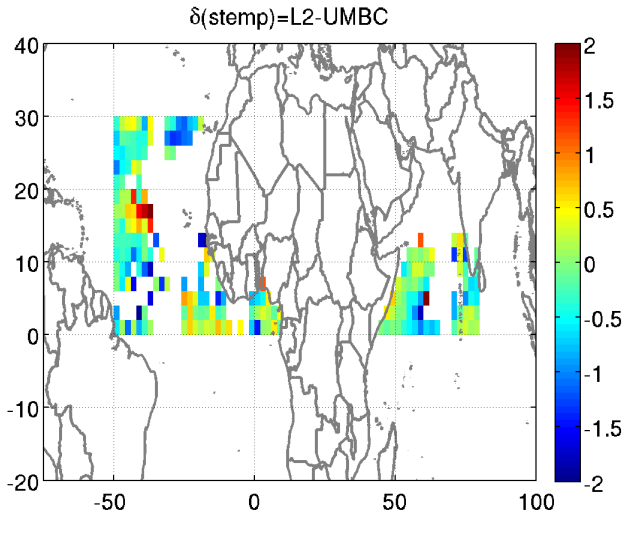


L2CCR w/ no dust: SST

(L) histogram



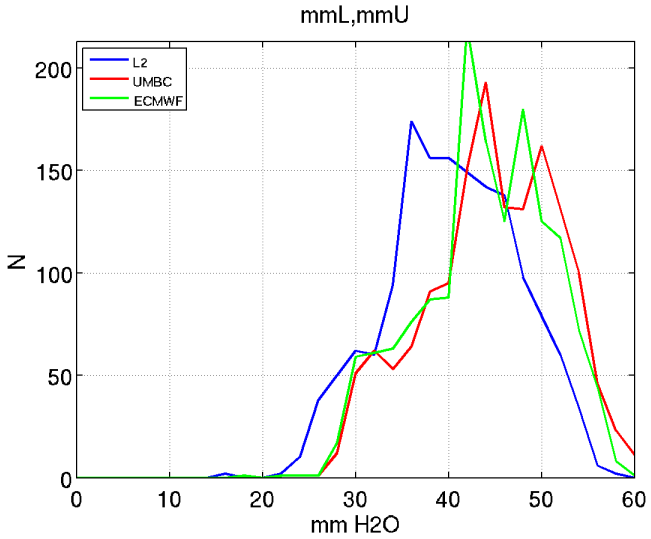
(R) map

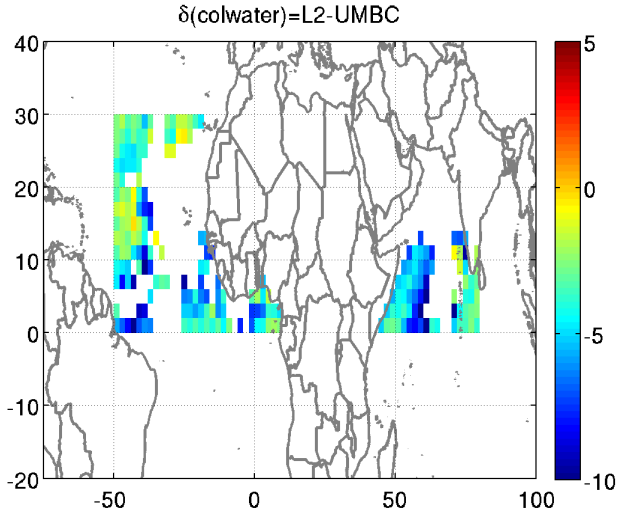


L2CCR w/ no dust: Column Water

UMBC seems to be wetter than L2?

(L) histogram (R) map





Dusty FOVS

We ran retrievals on both L1b and L2CC

Choose L2CC qual=0,1,2 "dusty" rads
Choose L1B "dusty" rads

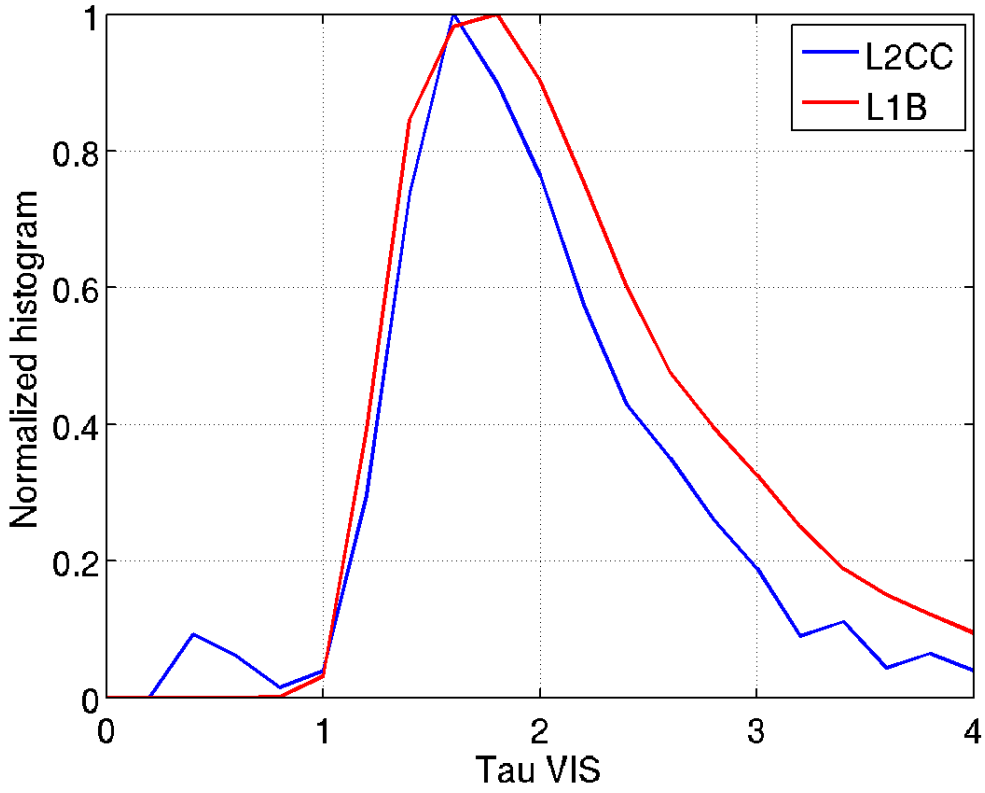
- biases and std devs look VERY similar for L2CC, L1B
- Retrieved profiles and SSTs, col water amts look very similar
- Retrieved dust OD looks similar (except at low OD end)

4595 L2CC profiles : 1780 = qual 0 (best), 2815 = qual 2 (bad)
We get the following yield

L2CCR quality	num FOVS	δBT_{max} = 1K	δBT_{max} = 2K
Qual=0 (best)	1780	0.77	0.84
Qual=1 (ok)	-	-	-
Qual=2 (bad)	2815	0.49	0.55
Qual=0,1,2 (all)	4595	0.60	0.67

Dusty FOVS Optical Depths

Though ODs from L2CC are different than ODs from L1B at small τ end, we can get some good dust science with L2CC!!!!



Retrievals : 06/21-26/08 : Overall message

Compare to L2 sup products against UMBC retrievals

- if L2CCR qual = 0, can improve L2 yield *down to surface* by $\gg$ 300%!!!
- if L2CCR qual = 2, UMBC gets a larger yield than L2
- No correlation of "surf" qual flag with retrieved dust OD

Larger UMBC retrieved dust amounts correlate with reduced L2 retrieved emissivity.

To get same BT(820),BT(960),BT(1231), this means L2 has to

- increase *stemp* as *emis* decreases (negative correlation) AND/OR
- decrease *colwater* as *emis* decreases (positive correlation)

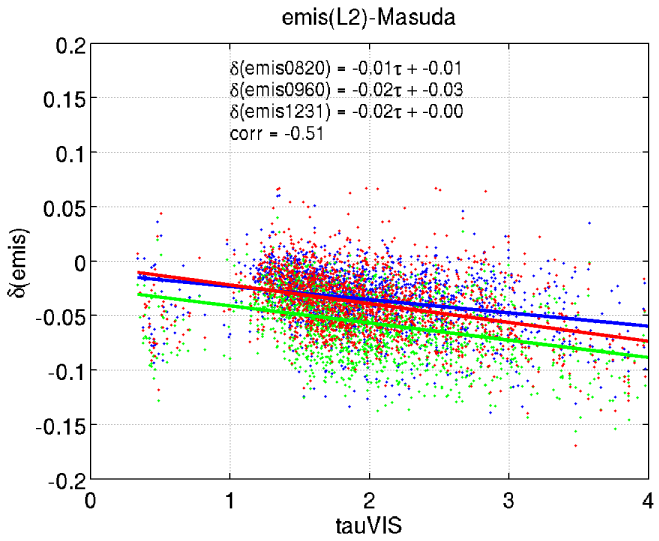
For the 1780 L2CCR qual=0 (best), 2815 L2CCR qual=2 (bad) Fovs, (Cloud_OLR, Temp_Profile_Bot, H2O, Surf) quality flags for L2 products gives following stats

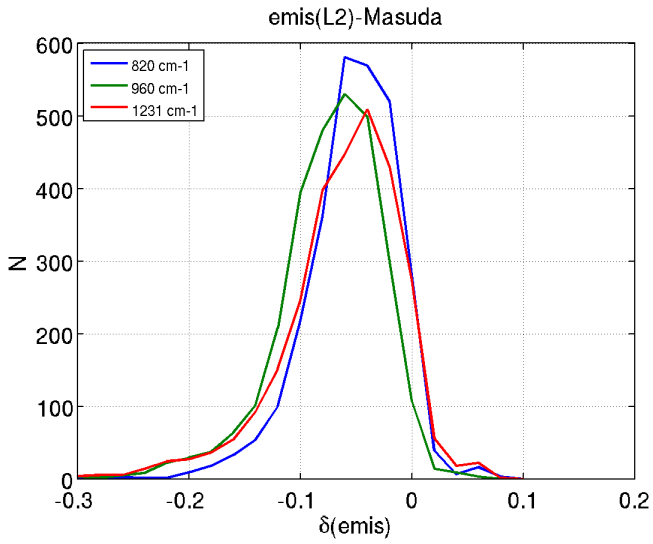
L2 product	quality flag	yield (L2CCRqual=0)	yield (L2CCRqual=2)
olr	0	1.00	1.0
olr	0,1	1.00	1.0
surf	0	0.02	0
surf	0,1	0.25	0
temp	0	0.76	0
temp	0,1	1.00	0
water	0	0.76	0
water	0,1	0.99	0.99
UMBC	δBT_{max} = 1 K	0.77	0.49
UMBC	δBT_{max} = 2 K	0.84	0.56

L2 vs UMBC : emissivity change L2-UMBC

U = UMBC retrieval, L = L2 product
blue = 820, green = 960, red = 1231 cm-1
Note the negative correlation
Correlations gets stronger for qual=2

(L) correlation (qual=0) (R) histogram (qual=0)

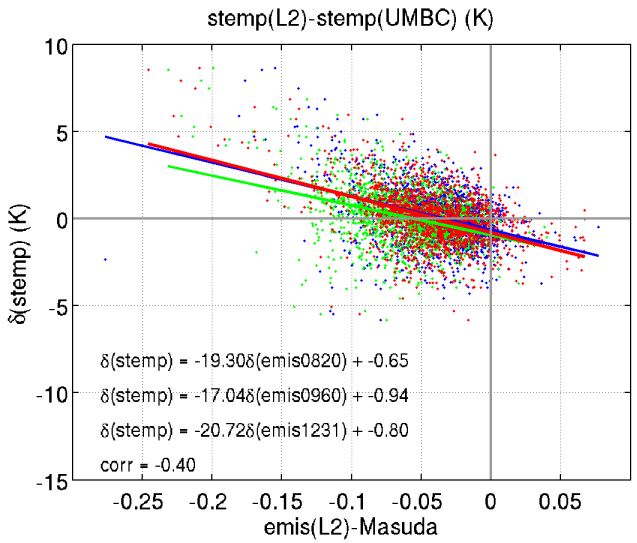


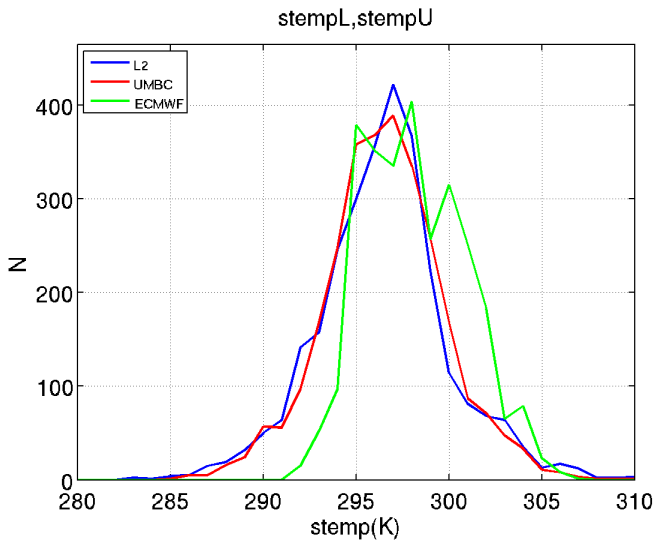


L2 vs UMBC : Correlate emissivity change with stemp change

U = UMBC retrieval, L = L2 product
Emis at 820 cm^{-1} (blue), 960 cm^{-1} (green) and 1231 cm^{-1} (red)
Note the negative correlation
blue = 820, green = 960, red = 1231 cm-1

(L) correlation (qual=0) (R) histogram (qual=0)

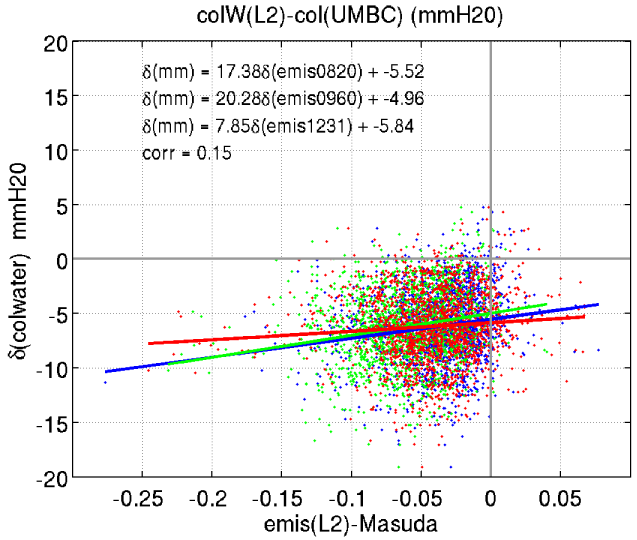


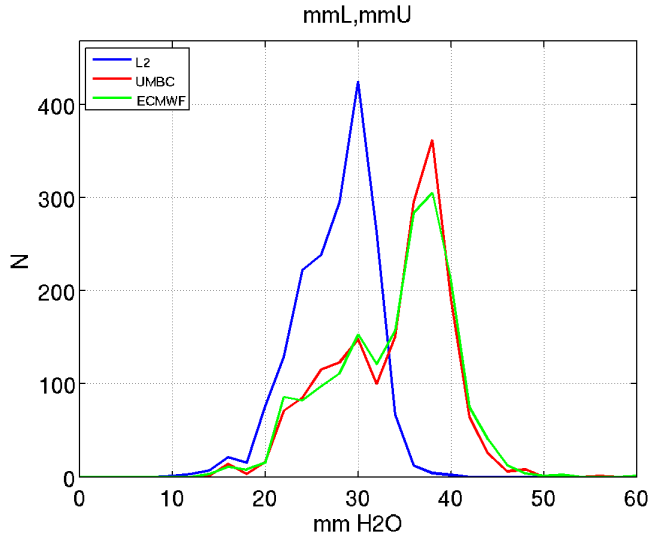


L2 vs UMBC : Correlate emissivity change with col water change

U = UMBC retrieval, L = L2 product
Emis at 820 cm^{-1} (blue), 960 cm^{-1} (green) and 1231 cm^{-1} (red)
Note the positive correlation
UMBC retrievals are even more “wet” than L2 retrievals (compared to the random clear case)
blue = 820, green = 960, red = 1231 cm-1

(L) correlation (qual=0) (R) histogram (qual=0)

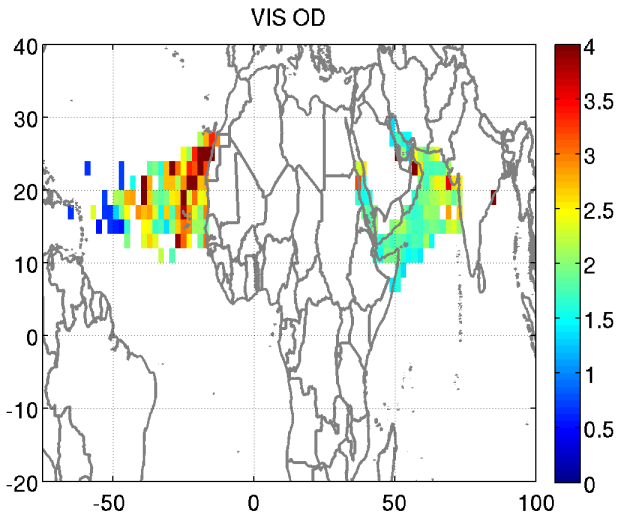


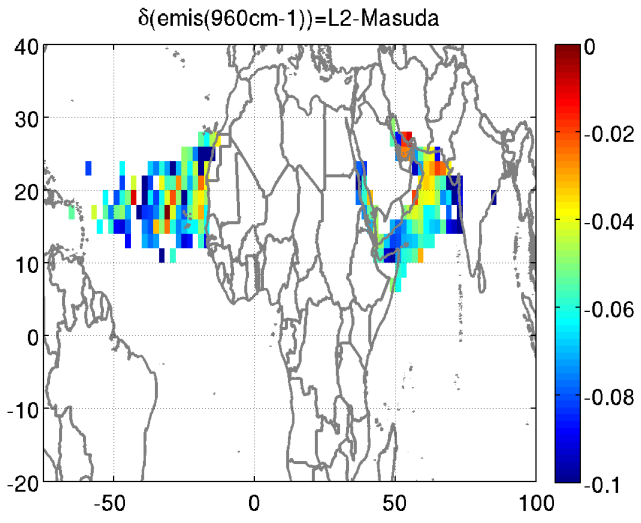


L2 vs UMBC : Tau and delta(emiss) for L2CCR qual=0

U = UMBC retrieval, L = L2 product

(L) UMBC τ (R) δ emiss = L2-UMBC

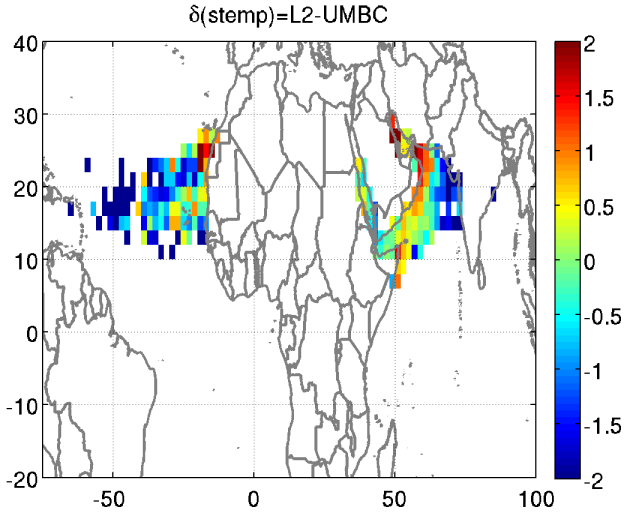


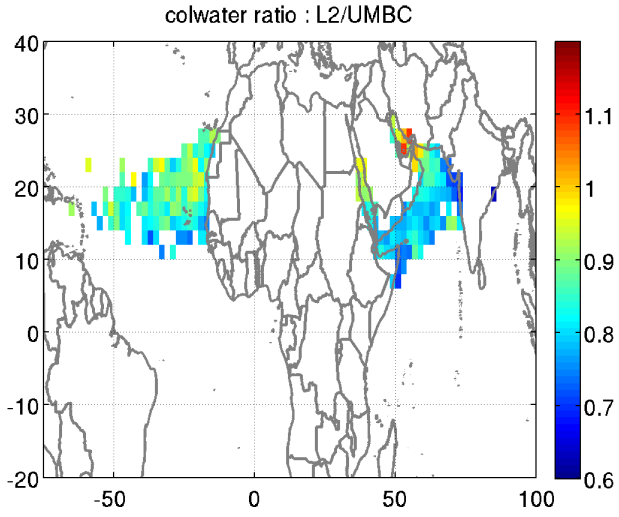


L2 vs UMBC : ratio(colwater) and delta(stemp) for L2CCR qual=0

U = UMBC retrieval, L = L2 product

(L) δ stemp = L2-UMBC (R) colwater ratio= L2/UMBC





Conclusions

- A dust retrieval in the L2 PGE will (1) increase yields and (2) improve accuracy (esp. col water, a key AIRS parameter).
- This will give us good T/Q/sfc retrievals, that in turn provide dust optical depth retrievals from AIRS, day and night.
- We have shown that AIRS can be as good, or superior (night, no sunglint or bright surface issues) than other instruments for dust loading. **We need to show the scientific community why hyperspectral sounding is more than just water vapor.**
- We *might* get good dust loading with L2CC based retreivals, but we prefer to using L1b that have little cloud contamination.
- This use of aerosols in SARTA can also be used for cirrus and water cloud retrievals, again making hyperspectral of more interest to the scientific community.